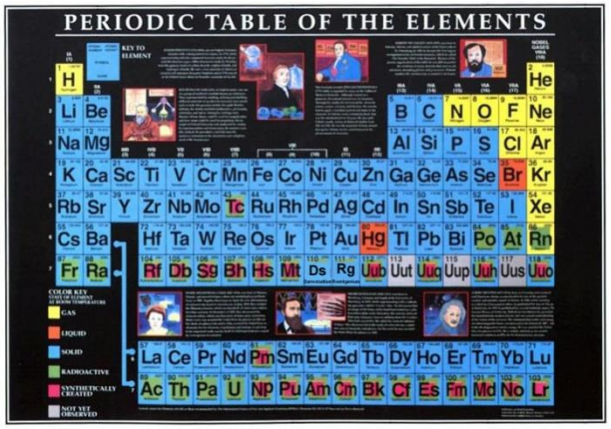
# *Bell Work*
# *3-Nov-17*

**If an $e^-$ escapes from an atom at a speed of $5.1 \times 10^4$ m/s and a wavelength of $1.0 \times 10^{-3}$m, what energy does it have?**



**EQ: What is a parts of our community that is organized in a periodic fashion and how does this help us?**

## *OBJECTIVES:*

**Start exploring the sections of the periodic table.**

# *Sections of The Periodic Table*

If you need coloring tools come in before or after school ☺

Due end of class, 7-Nov-2017

# Bell Work
# 7-Nov-2017

What metal is liquid at room temperature?
How many protons does this metal have?
What section of the periodic table is the metal located in?

# *OBJECTIVES:*

**Determine** the organization of a set of elements in a periodic fashion

**EQ: What is a parts of our community that is organized in a periodic fashion and how does this help us?**

# *Bell Work*
# *6-Nov-2017*

**The periodic table is arranged by increasing _____?**

**The periodic table can be split up in to 2 pieces: transition metals and _____?**

# *OBJECTIVES:*

**<u>Graphically</u> show how periodicity of the elements are depicted on Mendeleev's periodic table.**

**EQ: What is a parts of our community that is organized in a periodic fashion and how does this help us?**

# *Organizing the Elements*

**A few elements, such as gold and copper, have been known for *thousands of years* - since ancient times**

**Yet, only about 13 had been identified by the year 1700.**

**As more were discovered, chemists realized they needed a way to <u>organize</u> the elements.**

# *Organizing the Elements*

**Chemists used the *properties* of elements to sort them into groups.**

**In 1829 J. W. Dobereiner arranged elements into <u>triads</u> – groups of three elements with similar properties**

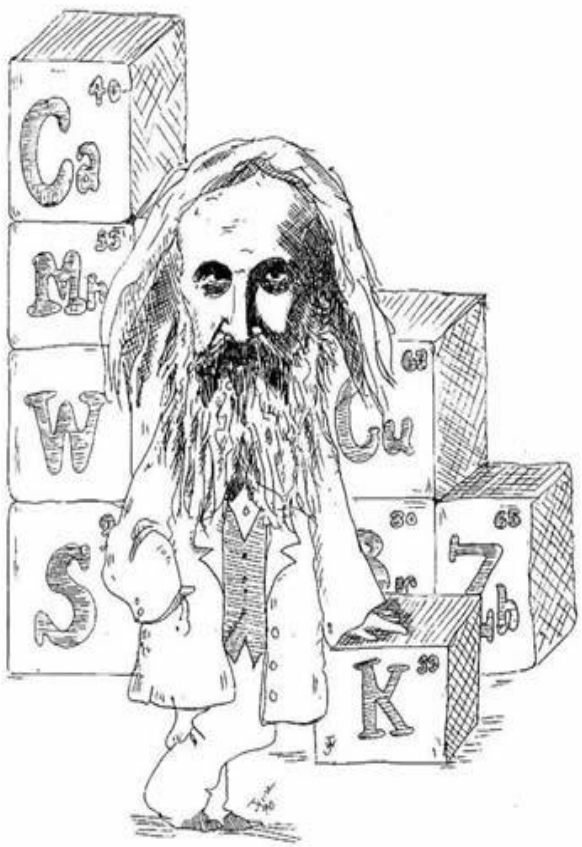
- One element in each triad had *properties* intermediate of the other two elements

# *Mendeleev's Periodic Table*

**By the mid-1800s, about 70 elements were known to exist**

**Dmitri Mendeleev – a Russian chemist and teacher arranged elements in order of increasing *atomic mass***

**Thus, the first "Periodic Table"**



# *Mendeleev*

***He left blanks*** **for yet undiscovered elements**

When they were discovered, he had made good predictions

**But, there were problems ☹:**

Such as Co and Ni; Ar and K; Te and I

# Bell Work
# 8-Nov-2017

Get out your periodic table and locate the six sections of the periodic table;

| | |
|---|---|
| **Transition elements,** | **Actinides,** |
| **Halogens,** | **Lanthanides,** |
| **Alkali metal** | **Alkaline earth metals** |

**Try to label a rectangle version of the table with each section from memory**

**Get a Yellow Lab handout from front of room "Plotting Trends" and start skimming over it**

# *Turn In, 8.Nov.17*

1. Flame Test Lab
2. Section of the Periodic Table
3. Creating a Periodic Table

# *Plotting Trends*
# *A Periodic Table Activity*

Your group will consist of three (3) people

**You need to do all of the calculations first!**

# *Plotting Trends*
# *A Periodic Table Activity*

Tips: Find the **maximum** value of the assigned physical property for the elements you are assigned

**Let the length of the straw minus one (1.0) cm represent this maximum value**

Use his portion of the straw

Using this "straw" scale as a ratio, calculate the straw length that is needed to represent the assigned property for each element in your list

# *Plotting Trends*
# *A Periodic Table Activity*

Each group chooses or is assigned 1 element property:

1. Atomic mass (periodic table),
2. Atomic radius (Appendix A, Table A-3)
3. Ionization energy(Appendix A, Table A-3)
4. Electronegativity (Page 303 Table 12.1)
5. Electron Affinity (page 263 table 10.5)
6. Density (Appendix A, Table A-3)
7. Melting point(Appendix A, Table A-3).
8. Specific Heat (Appendix A, Table A-3)
9. Abundance on Earths Crust (Appendix A, Table A-3).

# *Prepping the Element Straws*

Read number seven (7) on the lab handout:

Add 1.0cm to each length you calculated

# *On Your Well Plate*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| H | | | | | | | | | | | He |
| Li | Be | | | | | B | C | N | O | F | Ne |
| Na | Mg | | | | | Al | Si | P | S | Cl | Ar |
| K | Ca | | | | | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | | | | | In | Sn | Sb | Te | I | Xe |

# *Bell Work*
# *9-Nov-2017*

Have your Straw scale 3D periodic table ready to build.

Yellow Card with Trend name and Description of trend;

Ex. "Atomic Fortitude"

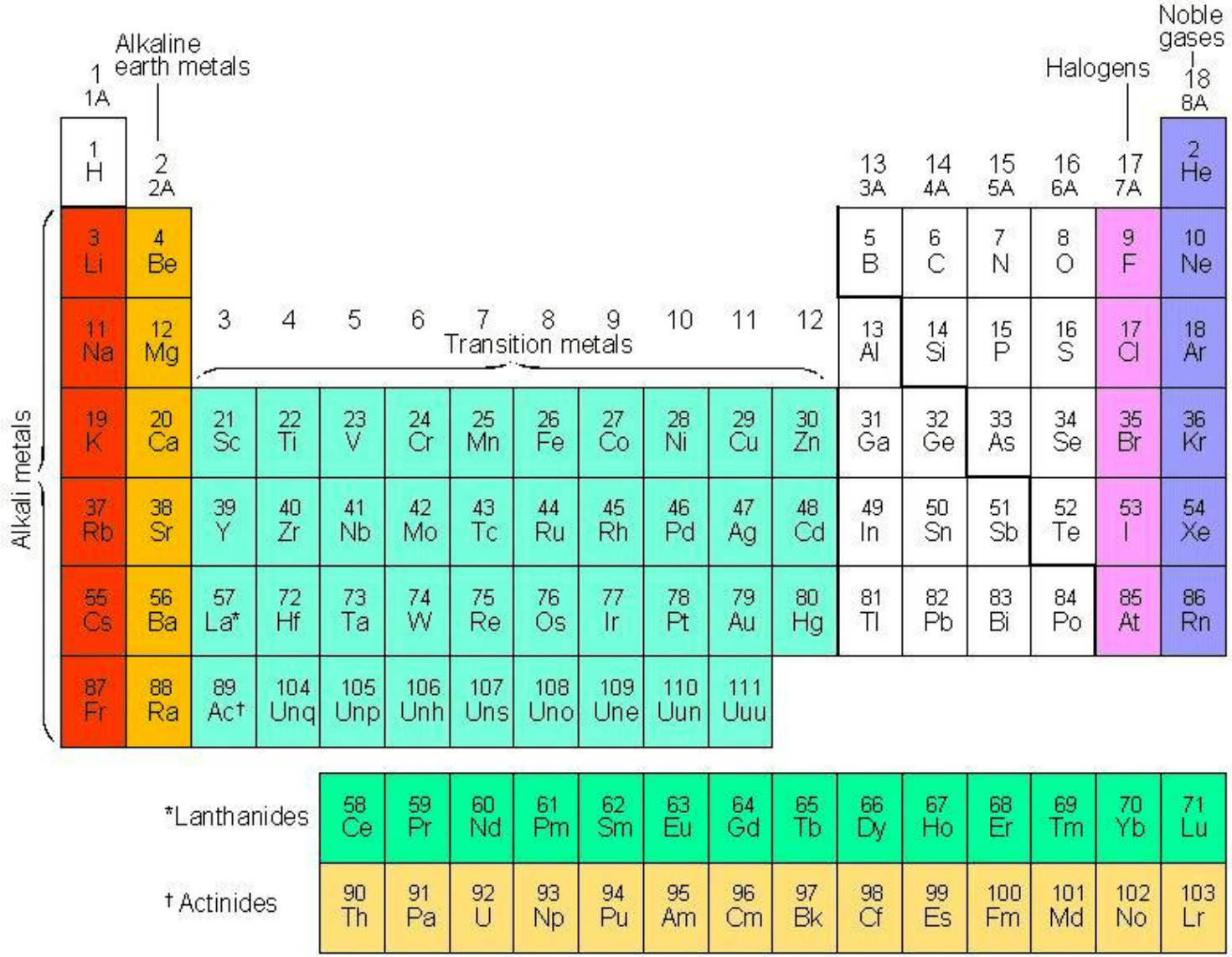
Increases to right and Down a Row

# *OBJECTIVES:*

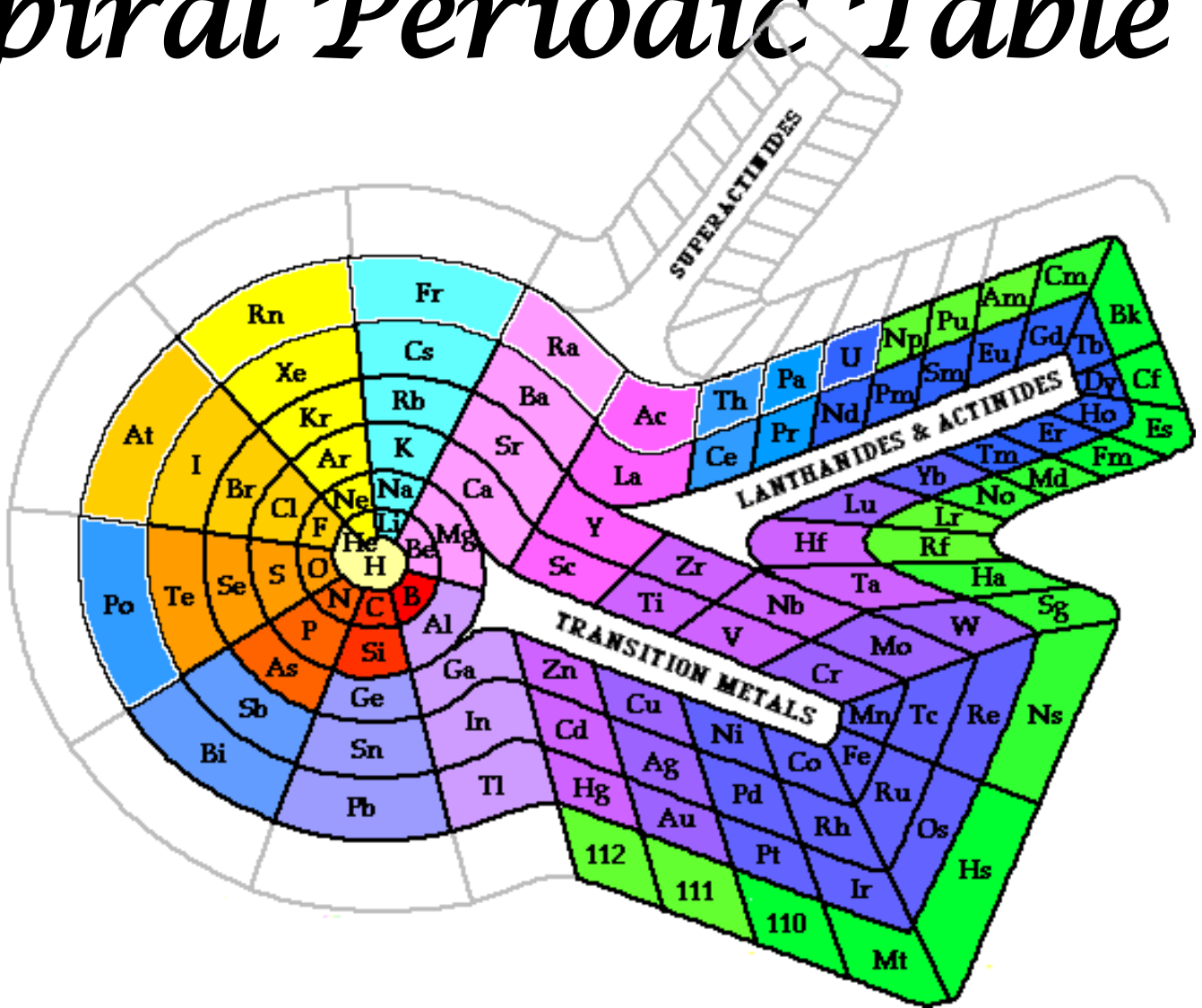
- **Begin to understand the trends on the periodic table as seen through a 2D graph and be able to explain the current modern arrangement/ section of the periodic table according to periodic law**

# *A Better Arrangement*

- **In 1913, Henry Moseley – British physicist, arranged elements according to increasing *atomic number***
- **The arrangement used today**
- **The symbol, atomic number & mass are basic items included- textbook page 144 and 145**


Alkaline earth metals
Halogens
Noble gases
1 1A
2 2A
13 3A
14 4A
15 5A
16 6A
17 7A
18 8A
Alkali metals
3 4 5 6 7 8 9 10 11 12
Transition metals
1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
14 Si
15 P
16 S
17 Cl
18 Ar
19 K
20 Ca
21 Sc
22 Ti
23 V
24 Cr
25 Mn
26 Fe
27 Co
28 Ni
29 Cu
30 Zn
31 Ga
32 Ge
33 As
34 Se
35 Br
36 Kr
37 Rb
38 Sr
39 Y
40 Zr
41 Nb
42 Mo
43 Tc
44 Ru
45 Rh
46 Pd
47 Ag
48 Cd
49 In
50 Sn
51 Sb
52 Te
53 I
54 Xe
55 Cs
56 Ba
57 La*
72 Hf
73 Ta
74 W
75 Re
76 Os
77 Ir
78 Pt
79 Au
80 Hg
81 Tl
82 Pb
83 Bi
84 Po
85 At
86 Rn
87 Fr
88 Ra
89 Ac†
104 Unq
105 Unp
106 Unh
107 Uns
108 Uno
109 Une
110 Uun
111 Uuu
*Lanthanides
58 Ce
59 Pr
60 Nd
61 Pm
62 Sm
63 Eu
64 Gd
65 Tb
66 Dy
67 Ho
68 Er
69 Tm
70 Yb
71 Lu
† Actinides
90 Th
91 Pa
92 U
93 Np
94 Pu
95 Am
96 Cm
97 Bk
98 Cf
99 Es
100 Fm
101 Md
102 No
103 Lr

# Another possibility: Spiral Periodic Table



# *The Periodic Law says:*

When elements are arranged in order of increasing atomic number, there is a ***periodic repetition*** of their physical and chemical properties.

**Horizontal rows = periods**

**There are 7 periods**

**Vertical column = group (or family)**

Similar physical & chemical prop.

Identified by number & letter (IA, IIA)

# *Areas of the periodic table*

**Three classes of elements are**


**1) metals**

**2) nonmetals**

**3) Metalloids**

**Metals**: electrical conductors, have luster, ductile, malleable

**Nonmetals**: generally brittle and non-lustrous, poor conductors of heat and electricity

# *Optional Activity: Interactive Periodic Trends: A Graphical Experience.*

Please open up the file "Online Periodic Properties" in the homework section of the class website (not loaded yet, Nov2017).

You should complete the handout *on a separate sheet of paper*.

http://academic.pgcc.edu/~ssinex/excelets/PT_interactive.xls

# *Areas of the periodic table*

**Some nonmetals are gases**

**(O, N, Cl); some are brittle solids (S); one is a fuming dark red liquid (Br)**

**Notice the heavy, stair-step line?**

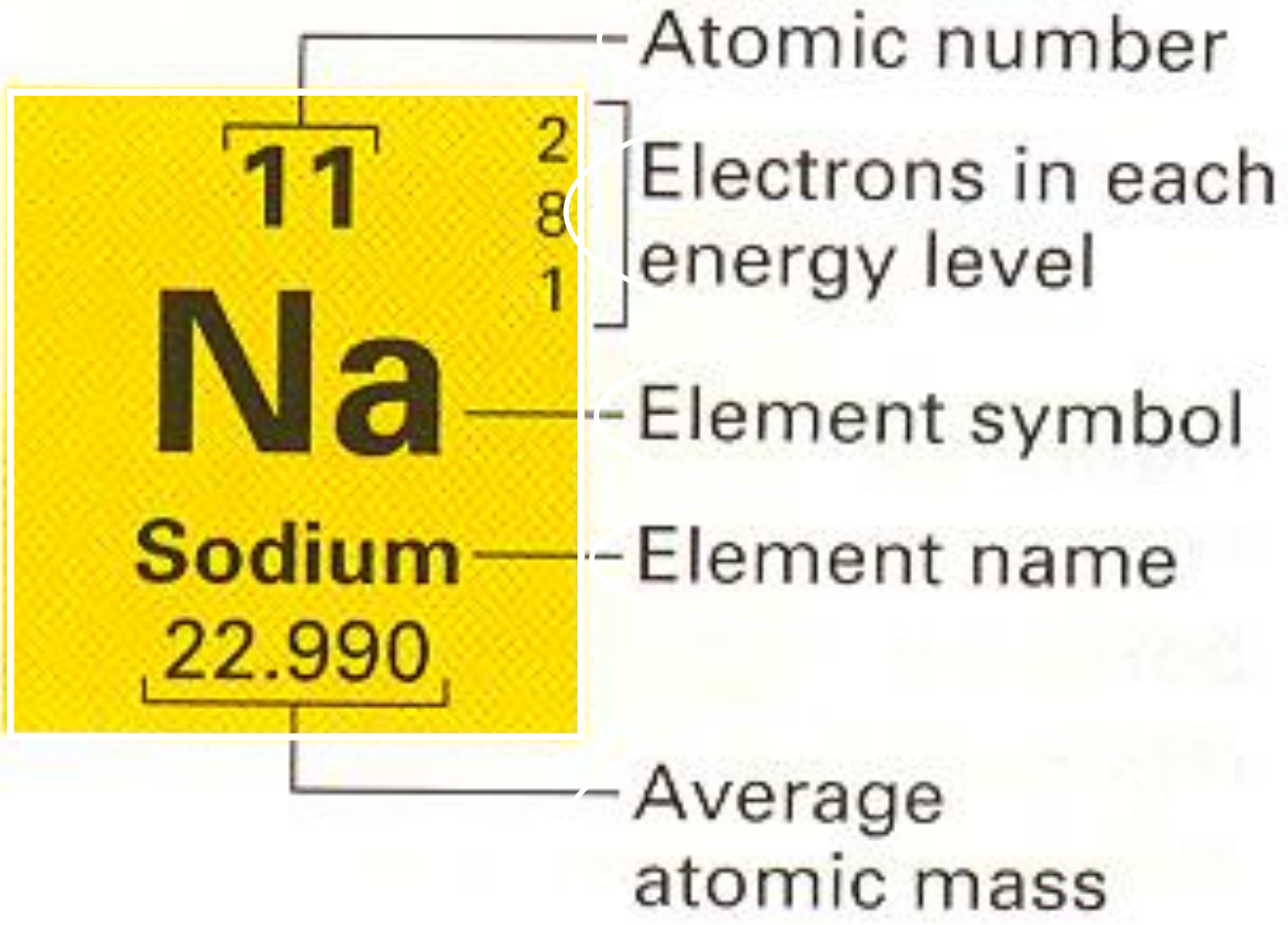
Metalloids: **border the line-2 sides**

Properties are *intermediate* between metals and nonmetals

# *Tiles on the Periodic Table*

**The periodic table displays the symbols and names of the elements, along with information about the structure of their atoms:**

- Atomic number and atomic mass
- **Black symbol = solid**;
- **red = gas**;
- **blue = liquid**
- **(from the Periodic Table on our classroom wall)**


11
2
8
1
Na
Sodium
22.990
Atomic number
Electrons in each energy level
Element symbol
Element name
Average atomic mass

# *Groups of elements* – *family names*

Group IA – **alkali metals**

Forms a "base" (or alkali) when *reacting* with water (not just dissolved!)

Group IIA – **alkaline earth metals**

Also form bases with water; do not dissolve well, hence "earth metals"

Group VIIA – **halogens**

Means "salt-forming"

# *Electron Configurations in Groups*

**Elements can be sorted into 4 different groupings *based on their electron configurations*:**

- **Noble gases**
- **Representative elements**
- **Transition metals**
- **Inner transition metals**

# *3D Plotting Trends*

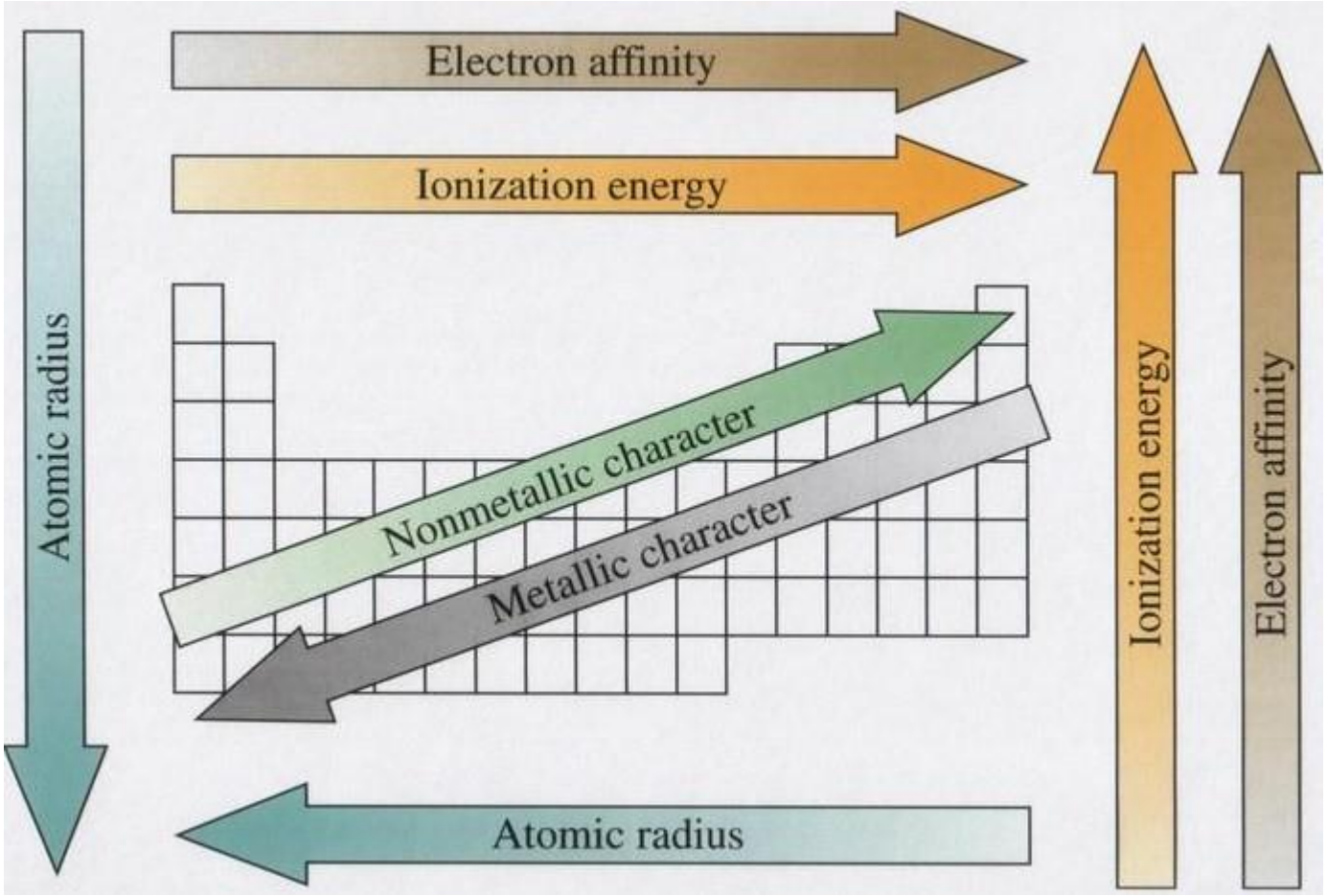
As a group you will introduce your "trend"

On the green card, you will draw a rectangle (to represent the periodic table) and record the trends.

# *On Your Well Plate*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| H | | | | | | | | | | | He |
| Li | Be | | | | | B | C | N | O | F | Ne |
| Na | Mg | | | | | Al | Si | P | S | Cl | Ar |
| K | Ca | | | | | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | | | | | In | Sn | Sb | Te | I | Xe |

# *Periodic Trends*



How would you describe the trend for atomic radius going from left to right across a period?

Down a group?

# *Recall*

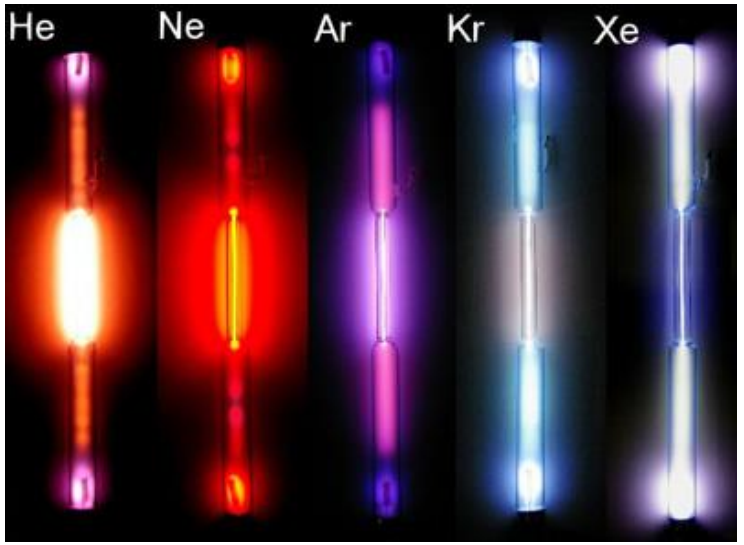
What is ionization energy?

What is an ion?

# *Nobel Gases*

Noble gases **are the elements in Group 8A, VIIIA (also called Group18)**

Previously called "**inert gases**" because they rarely take part in a reaction; very stable = don't react



# *Question*

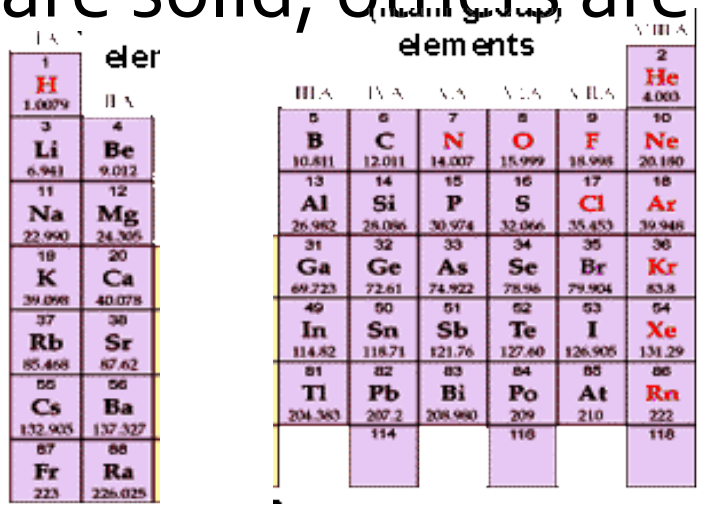
**What are the three classes of elements (hint: not the phases)**

# *Representative Elements*

## Representative Elements **are in Groups 1A through 7A**

Display wide range of properties, thus a good "representative"

Some are metals, or nonmetals, or metalloids; some are solid, others are gases or liquids

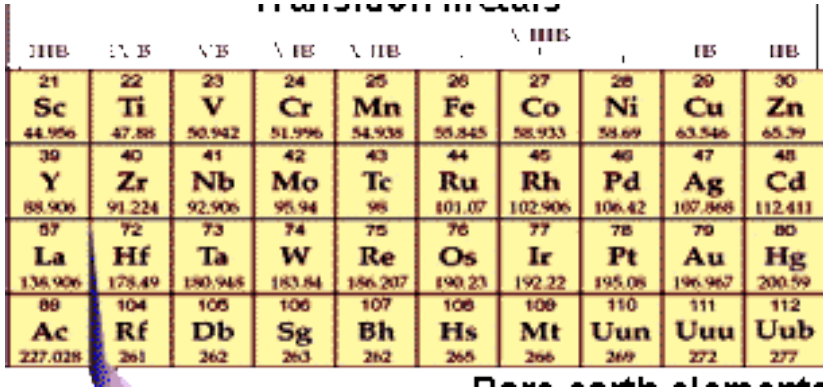


# *Transition Metals*

## Transition metals are in the "B" columns of the periodic table

A "transition" between the metal area and the nonmetal area

Examples are gold, platinum, silver

# *Inner Transition Metals*

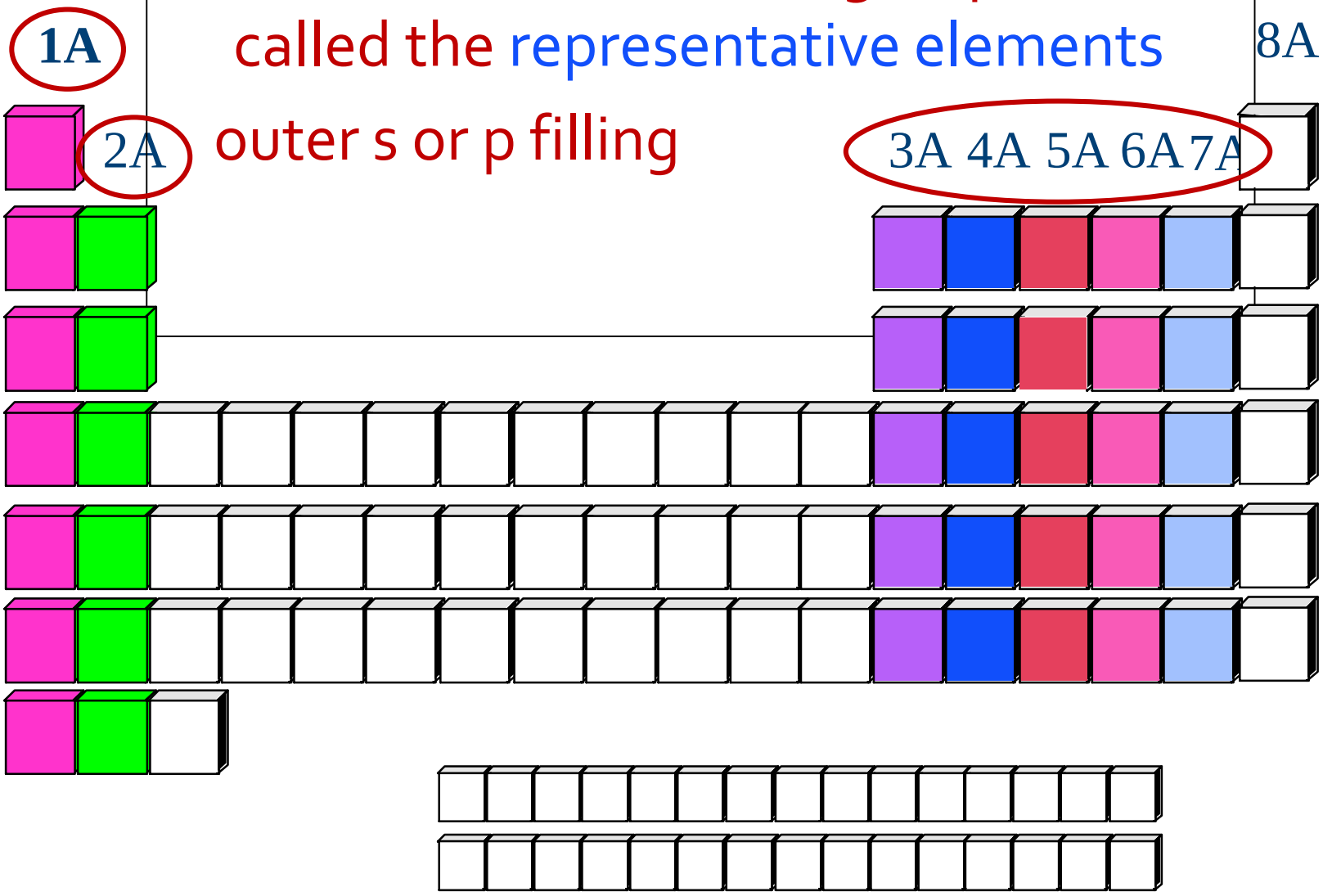
Inner Transition Metals **are located below the main body of the table, in two horizontal rows**

- Formerly called "rare-earth" elements, but this is not true because some are very abundant

Rare Earth Elements

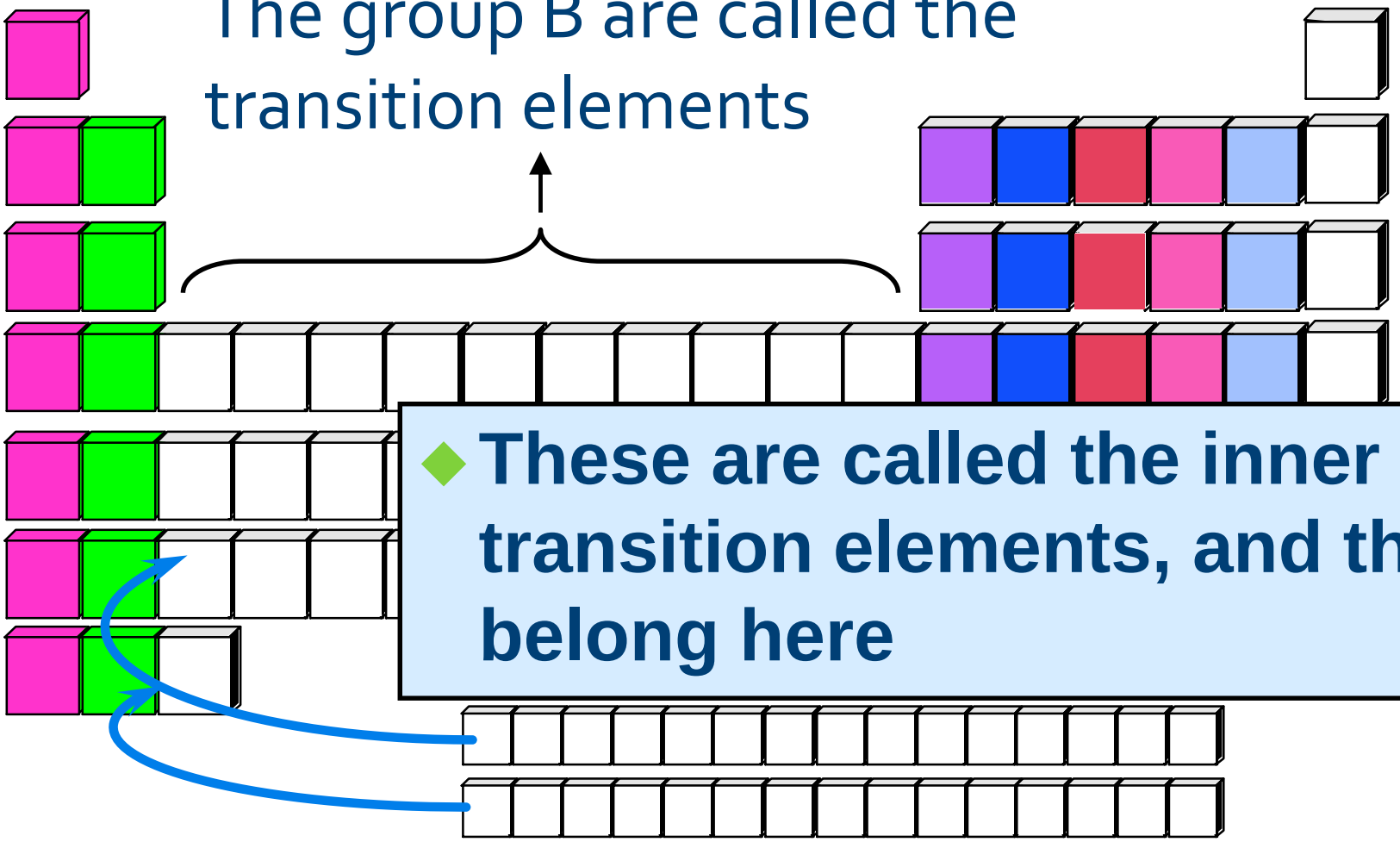
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 Ce 140.115 | 59 Pr 140.908 | 60 Nd 144.24 | 61 Pm 145 | 62 Sm 150.36 | 63 Eu 151.964 | 64 Gd 157.25 | 65 Tb 158.925 | 66 Dy 162.5 | 67 Ho 164.93 | 68 Er 167.26 | 69 Tm 168.934 | 70 Yb 173.04 | 71 Lu 174.967 |
| 90 Th 232.038 | 91 Pa 231.036 | 92 U 238.029 | 93 Np 237.048 | 94 Pu 244 | 95 Am 243 | 96 Cm 247 | 97 Bk 247 | 98 Cf 251 | 99 Es 252 | 100 Fm 257 | 101 Md 258 | 102 No 259 | 103 Lr 262 |

- Elements in the 1A-7A groups are called the representative elements




outer s or p filling

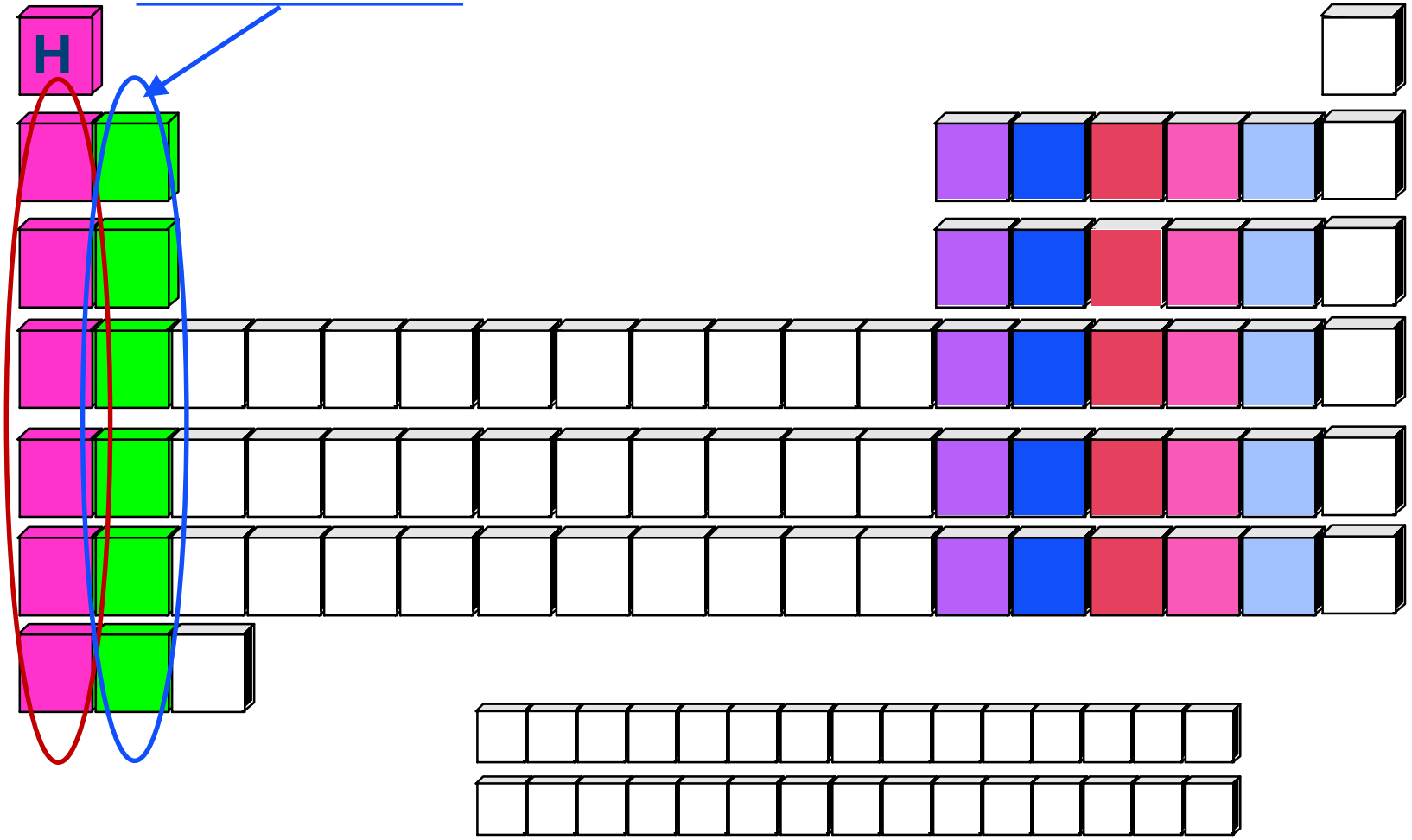
The group B are called the transition elements



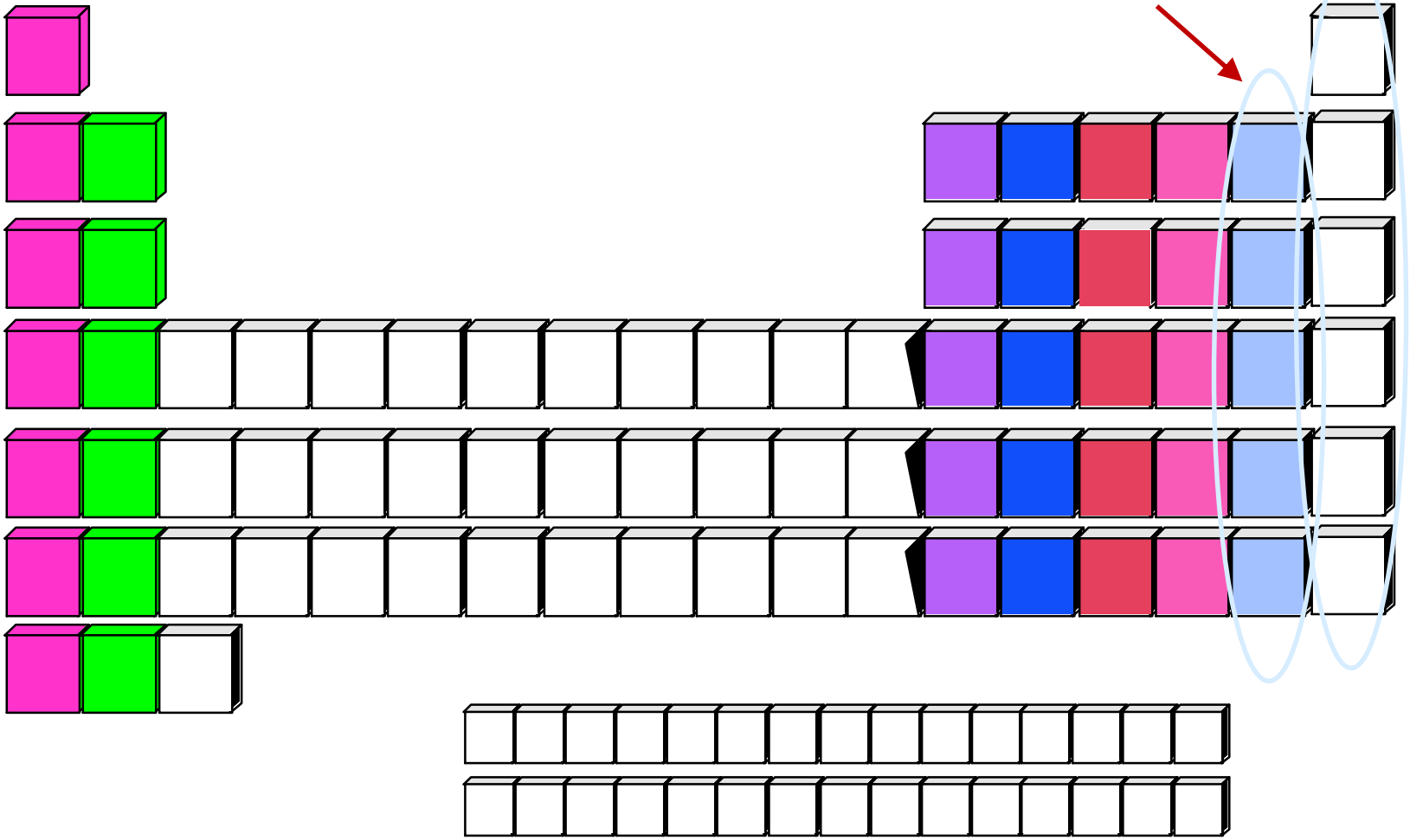
- **These are called the inner transition elements, and they belong here**

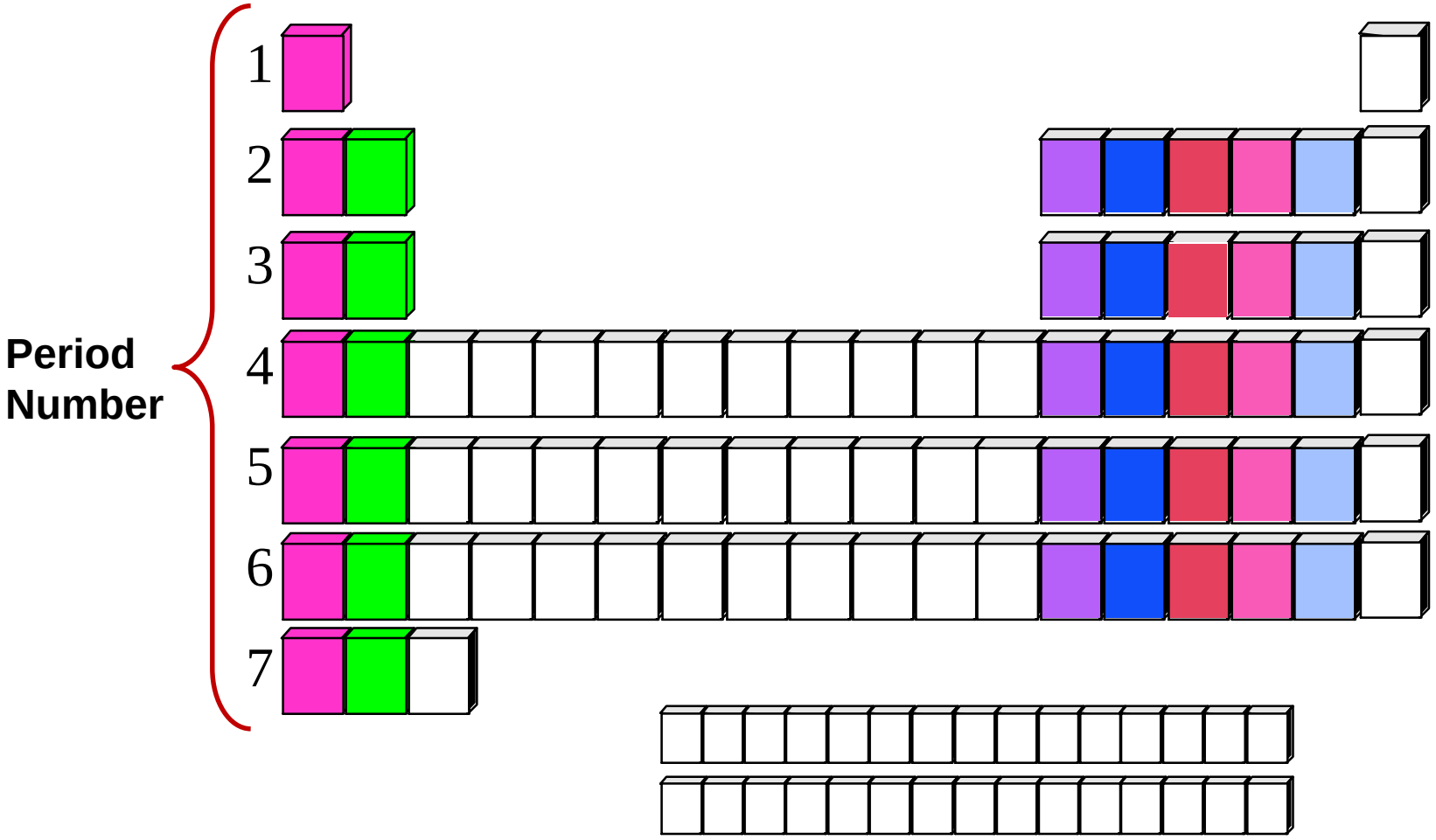
# Group 1A are the alkali metals (but NOT H)

## Group 2A are the alkaline earth metals



- Group 8A are the noble gases
- Group 7A is called the halogens



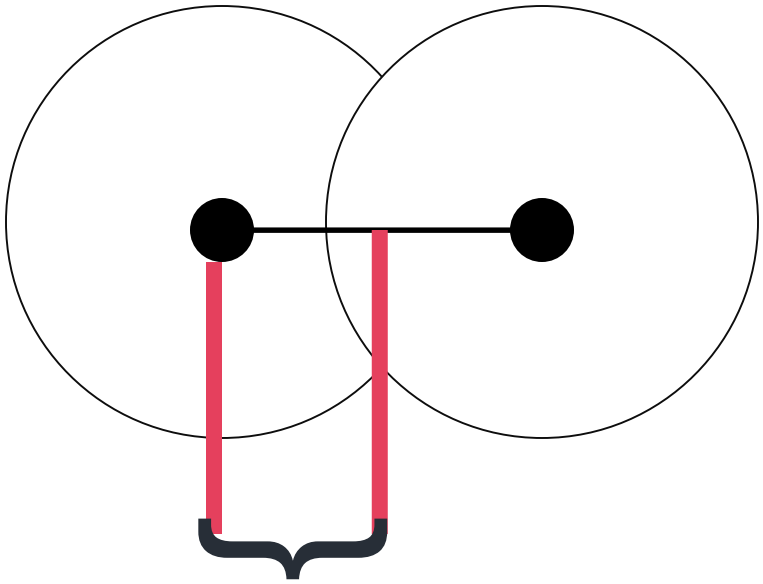



- Each row (or period) is the <u>energy level</u> for s and p orbitals.

# *Trends in Atomic Size*

- First problem: Where do you start measuring from?
- The electron cloud doesn't have a definite edge.
- They get around this by measuring more than 1 atom at a time.

# *Atomic Size*




- Measure the Atomic Radius - this is half the distance between the two nuclei of a diatomic molecule.

# *ALL Periodic Table Trends*

- Influenced by three factors:

1. Energy Level
   - Higher energy levels are further away from the nucleus.
2. Charge on nucleus (# protons)
   - More charge pulls electrons in closer. (+ and – attract each other)
3. Shielding effect (blocking effect?)

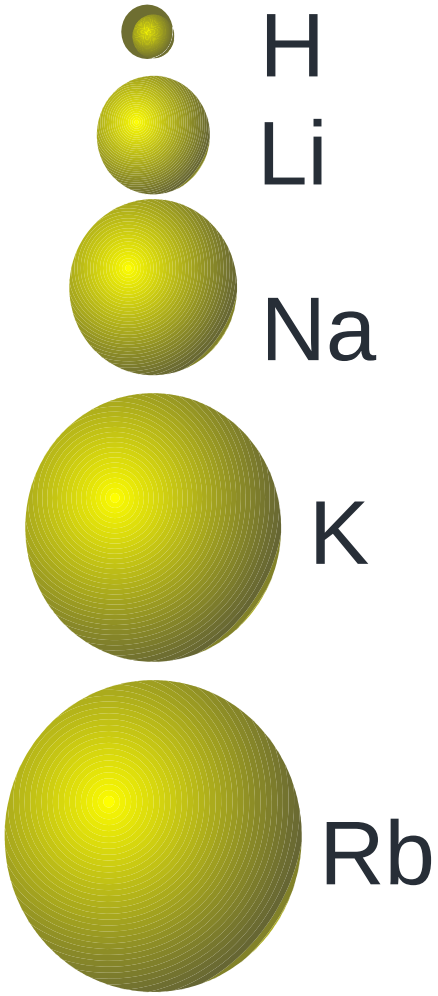
# *What do they influence?*

Energy levels and Shielding have an effect on the *GROUP*

Nuclear charge has an effect on a *PERIOD*

# #1. *Atomic Size* - *Group trends*

- As we increase the atomic number (or go down a group). . .
- each atom has another energy level,
- so the atoms get *bigger*.



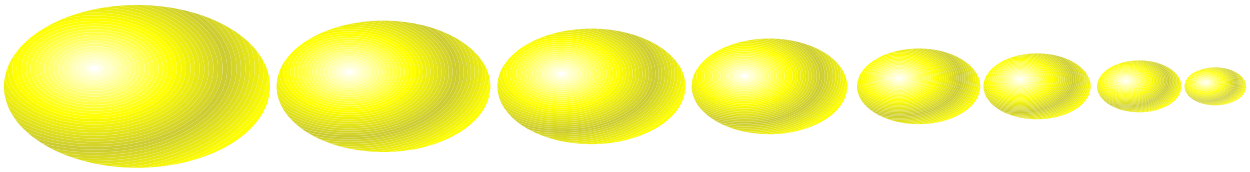
# #1. Atomic Size - Period Trends

Going from left to right across a period, the size gets smaller.

Electrons are in the same energy level.

But, there is more nuclear charge.

Outermost electrons are pulled closer.



Na Mg Al Si P S Cl Ar

# *Ions*

**Some compounds are composed of particles called "ions"**

- An **ion** is an atom (or group of atoms) that has a *positive or negative charge*

**Atoms** are neutral because the number of protons equals electrons

- Positive and negative ions are formed when electrons are *transferred* (lost or gained) between atoms

# *Ions*

## **Metals tend to LOSE electrons, from their outer energy level**

- Sodium loses one: there are now more protons (11) than electrons (10), and thus a positively charged particle is formed = "**cation**"
- The charge is written as a number followed by a plus sign: $Na^{1+}$
- Now named a "**sodium ion**"

# *Ions*

**<u>Nonmetals tend to GAIN</u> one or more electrons**

- Chlorine will gain one electron
- Protons (17) no longer equals the electrons (18), so a charge of -1
- $Cl^{1-}$ is re-named a "chloride ion"
- Negative ions are called "**<u>anions</u>**"

# #2. *Trends in Ionization Energy*

- Ionization energy is the amount of energy required to *completely remove an electron* (from a gaseous atom).
- Removing one electron makes a 1+ ion.
- The energy required to remove only the first electron is called the first ionization energy.

# *Ionization Energy*

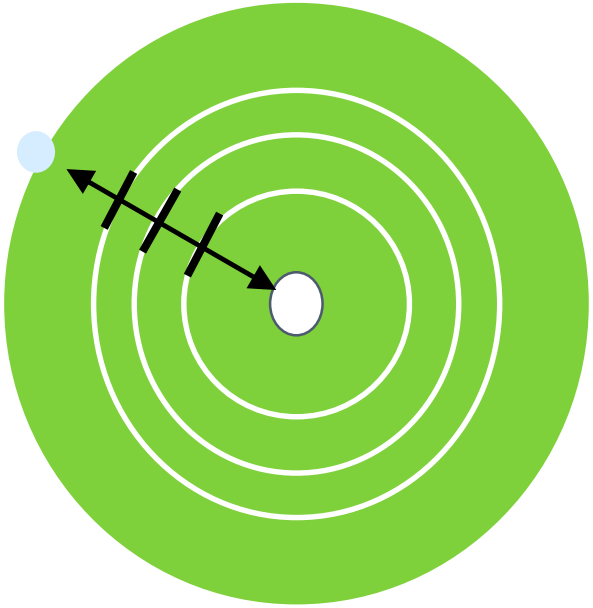
- The second ionization energy is the energy required to remove the second electron.
  - Always greater than first IE.
- The third IE is the energy required to remove a third electron.
  - Greater than 1st or 2nd IE.

# *What factors determine IE*

- The greater the nuclear charge, the *greater* IE.
- Greater distance from nucleus *decreases* IE
- Filled and half-filled orbitals have lower energy, so achieving them is easier, lower IE.
- Shielding effect

# *Shielding*

- The electron on the outermost energy level has to look through all the other energy levels to see the nucleus.
- Second electron has same shielding, if it is in the same period



# *Ionization Energy – Group trends*

As you go down a group, the first IE decreases because…

- The electron is further away from the attraction of the nucleus, and
- There is more shielding.

# *Ionization Energy - Period trends*

- All the atoms in the same period have the same energy level.
- Same shielding.
- But, increasing nuclear charge
- So IE generally increases from left to right.
- Exceptions at full and 1/2 full orbitals.

# *Driving Forces*

- *Full Energy Levels* require lots of energy to remove their electrons.
  - Noble Gases have full orbitals.
- Atoms behave in ways to try and achieve a noble gas configuration.

# *2nd Ionization Energy*

For elements that reach a filled or half-filled orbital by removing 2 electrons, 2nd IE is lower than expected.

True for $s^2$

Alkaline earth metals form 2+ ions.

# *3rd IE*

- Using the same logic $s^2p^1$ atoms have an low 3rd IE.
- Atoms in the aluminum family form 3+ ions.
- 2nd IE and 3rd IE are always higher than 1st IE!!!

# *Trends in Ionic Size: Cations*

- Cations form by losing electrons.
- Cations are **smaller** than the atom they came from – not only do they lose electrons, they lose an *entire energy level*.
- Metals form cations.
- Cations of representative elements have the noble gas configuration *before* them.

# *Ionic size: Anions*

- Anions form by gaining electrons.
- Anions are bigger than the atom they came from – have the same energy level, but a greater area the nuclear charge needs to cover
- Nonmetals form anions.
- Anions of representative elements have the noble gas configuration *after* them.

# *Configuration of Ions*

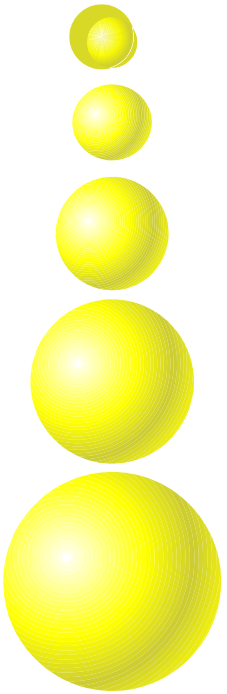
- Ions always have noble gas configurations ( = a full outer level)
- Na atom is: $1s^2 2s^2 2p^6 3s^1$
- Forms a 1+ sodium ion: $1s^2 2s^2 2p^6$
- Same configuration as neon.
- Metals form ions with the configuration of the noble gas *before* them - they lose electrons.

# *Configuration of Ions*

- Non-metals form ions by gaining electrons to achieve noble gas configuration.
- They end up with the configuration of the noble gas *after* them.

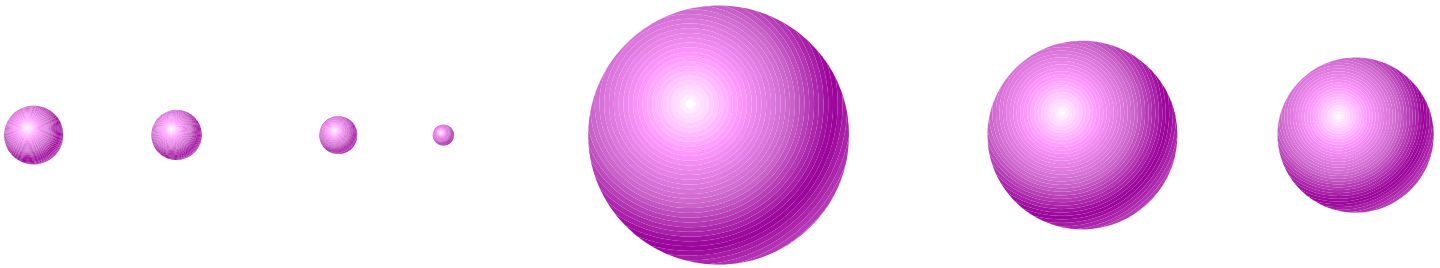
# *Ion Group trends*

- Each step down a group is adding an energy level
- Ions therefore get <u>bigger</u> as you go down, because of the additional energy level.



# *Ion Period Trends*

- Across the period from left to right, the nuclear charge increases - so they get <u>smaller.</u>
- Notice the *energy level changes* between anions and cations.

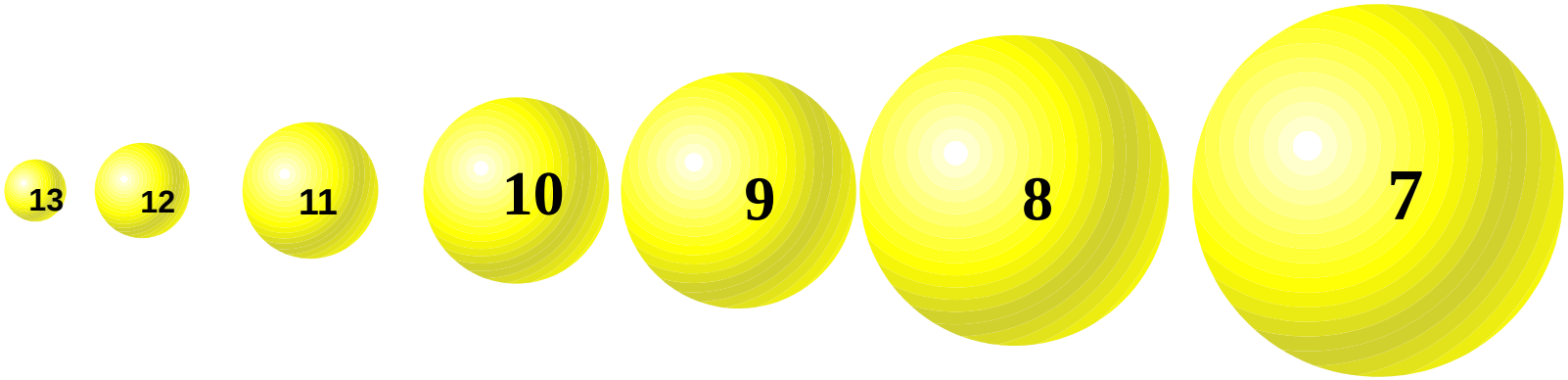


# *Size of Isoelectronic ions*

- Iso- means "the same"
- Isoelectronic ions have the same # of electrons
- $Al^{3+}$ $Mg^{2+}$ $Na^{1+}$ Ne $F^{1-}$ $O^{2-}$ and $N^{3-}$
  - all have 10 electrons
- all have the same configuration: $1s^2 2s^2 2p^6$ **(which is the noble gas: neon)**

# *Size of Isoelectronic ions?*

- Positive ions that have more protons would be *smaller* **(more protons would pull the same # of electrons in closer)**



# #3. Trends in Electronegativity

Electronegativity is the tendency for an atom to attract electrons to itself when it is chemically combined with another element.

They share the electron, but how equally do they share it?

An element with a big electronegativity means it pulls the electron towards itself strongly!

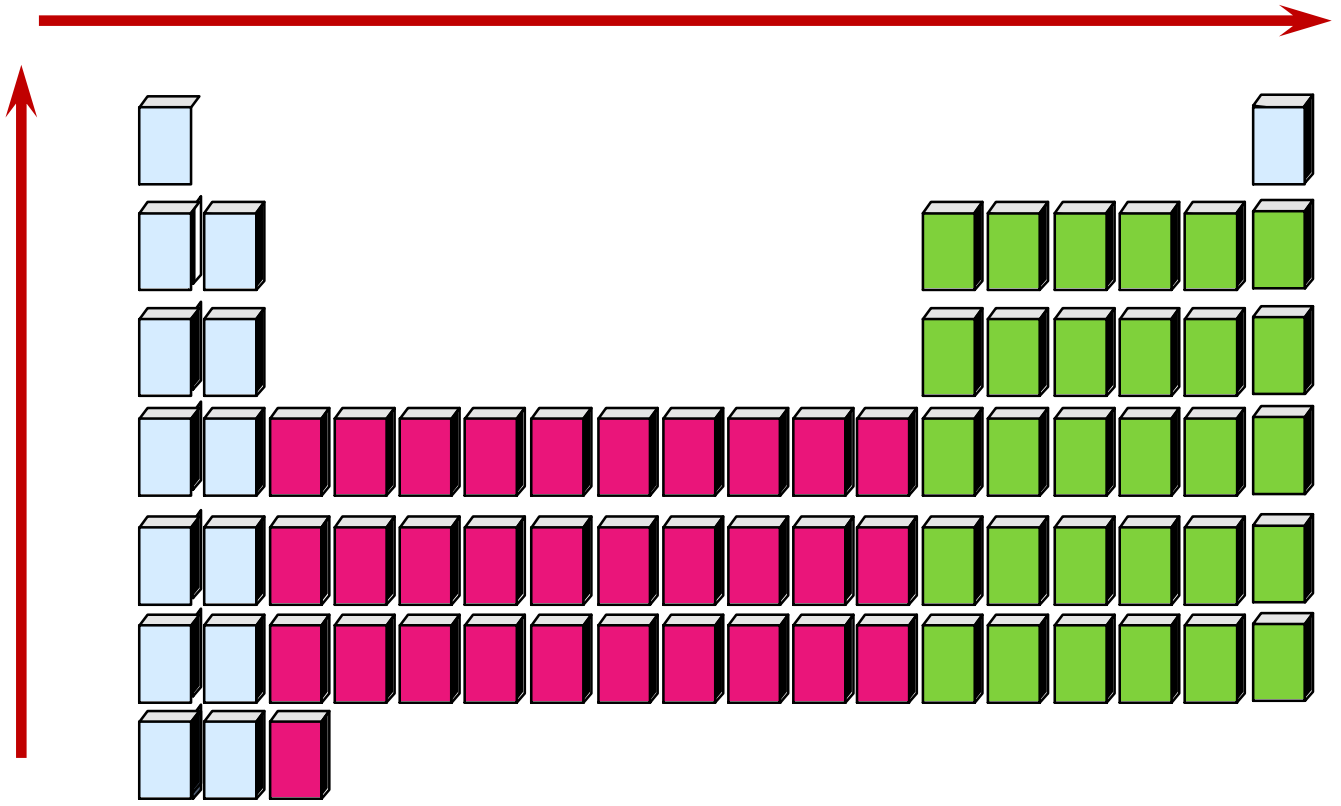
# *Electronegativity Group Trend*

- The further down a group, the farther the electron is away from the nucleus, plus the more electrons an atom has.
- Thus, more willing to share.
- Low electronegativity.

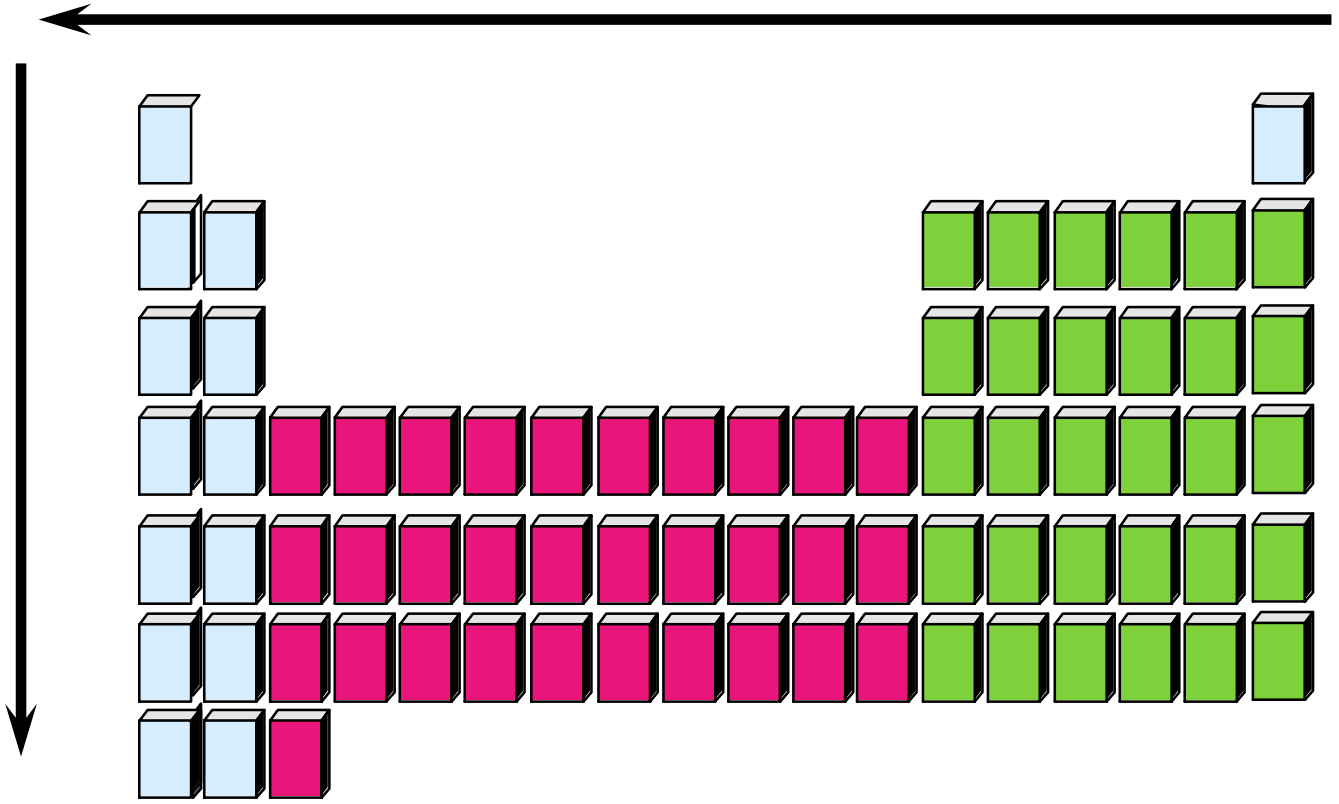
# *Electronegativity Period Trend*

- Metals are at the left of the table.
- They let their electrons go easily
- Thus, low electronegativity
- At the right end are the nonmetals.
- They want more electrons.
- Try to take them away from others
- High electronegativity.

The arrows indicate the trend:
Ionization energy and Electronegativity
*INCREASE* in these directions



# Atomic size and Ionic size increase in these directions:



# *Bell Work*
# *13-Nov-2017*

What is the **energy** associated with a photon from a **380nm** black light?

**What are the three (3) classes of elements (hint: not the phases)?**

**The last two (2) columns on the periodic table are refereed to as…?**

# *OBJECTIVES:*

- **You will be able to identify the sections and specific trends on the periodic table**
- **Turn in Bell Work**